Ordering Paradoxes and Lexical Phonology *

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1. *Introduction*

In this paper I consider a rule ordering paradox in Kimatuumbi, a Bantu language of Tanzania. The paradox in Kimatuumbi concerns two rules, Glide Formation and Lengthening, and their relative orderings at different lexical levels. The paradox is that at level 2 the rule Glide Formation precedes Lengthening, but at level 3 Glide Formation follows Lengthening. The violation of the antisymmetry of rule ordering is only apparent, and results simply from viewing ordering relations between rules as conditions on the entire set of rules in a grammar. There is no paradox if rule ordering relations are a function of a particular phonological level in the sense of the theory of lexical phonology.

I also suggest more generally that properties of rules are susceptible to change at different lexical levels. The properties subject to cross-stratal changes might be rule-ordering statements as in Kimatuumbi, or changes in the class of input segments, or a change from obligatory to optional application. The proposal that the form of a rule is not entirely fixed might be implemented by viewing the core of a rule as being in a sense underspecified, and having missing properties filled in at particular levels. One of the properties a rule will have which is tied to particular levels even in the current conception of grammatical organisation in lexical phonology is a specification of the levels at which a rule applies.

As a preliminary to arguing for cross-level reordering in Kimatuumbi, I will briefly consider the issue of changes in the properties of rules between lexical levels. There are various cases in the literature where two formally uncollapsible rules are, according to at least some people's theoretical intuitions, one rule. Mohanan (1982) discusses two rules in Malayalam, *n*- deletion illustrated in (1) and nasal-deletion, illustrated in (2).

(1) n → ∅ / ____ [C *n-deletion* (Level 1)

aaroogyam	'health'	an-aaroogyam	'ill health'
aikyam	'unity'	an-aikyam	'disunity'
sukham	'happiness'	a-sukham	'unhappiness'
kramam	'order'	a-kramam	'disorder'

(2) nasal → ∅ / ____ [*nasal-deletion* (Level 2, 3)

[wrksam] [agram] → [wrəksaagram]	'tree top'	(level 2)
[maram] [kutira] → [mara(k)kutira]	'wooden horse'	(level 2)
[sukham] [dukkham] → [sukhadukkham]	'pleasure and pain'	(level 3)
[sukham] [asukham] → [sukhaasukham]	'happiness and sorrow'	(level 3)

A number of dissimilarities between the two rules prevent them from being collapsed into one rule. The rule n-deletion only applies to n, only applies at level 1, and only applies before consonants. The more general nasal deletion rule applies at levels 2 and 3, applies to all nasals, and applies whether a consonant follows or a vowel follows. With the usual assumptions about rule writing, these differences are sufficient to prohibit (1) and (2) from being collapsed. However the rule applying at levels 2 and 3 is essentially identical to the earlier rule, with certain focal and environmental restrictions being dropped. Ignoring the question of a formal notation for level-dependent conditions on rules, a unified rule of nasal deletion in Malayalam might be written as in (3).

(3) +nasal → ∅ / ———] ⟨C⟩ Level 1: conditions present
⟨+coronal⟩ Level 2, 3: not present

The meaning of the angled brackets and level-conditions is simply that at level 1, the conditions on the rule enclosed in angled brackets must be satisfied, while at levels 2 and 3, the conditions are dropped. The reason why such a collapsing is not so immediately obvious is that neither of the two independent rules of nasal deletion is tremendously complex or unnatural, so there is not an overwhelming sense that a major generalization has been lost by having two unrelated nasal deletion rules.

Another case of phonological rules exhibiting changing properties at different phonological levels is Shona, which has a number of tone rules which are functionally similar but which cannot be collapsed into a single rule due to differences in morphological rule domain or minor differences in the conditioning environment, or due to ordering restrictions. In the analysis of Odden (1981), Shona has a number of H tone lowering rules, given in (4).

(4) *Rhythm:* H → L / H ___ H
[+prefix]

Associative Lowering: H → L / H ___
[+assoc.]

Clitic Lowering: H → L / H # ___

Sandhi Lowering: H → L / H (##) ___ ## H

The common element in all of these rules is simply 'H lowers after H', with additional phonological and morphological conditions being imposed on different manifestations of the rule. Each of the rules in (4) applies at a particular lexical or postlexical domain, as indicated diacritically by the use of boundaries and morphological features. The tonal grammar of Shona could be streamlined by treating some or all of these putatively separate lowering rules not as different rules but as the same rule, with different conditions imposed at various lexical strata. Similar analyses may allow the unification of the family of Greek vowel-deletion rules discussed by Kaisse (1985), or handle the level-determined conditions on a-raising rule in Sekani discussed in Hargus (1985).

2. *Kimatuumbi Phonology*

Let us now turn to the argument for level-determined changes in rule order. First some information about the morphology. Nouns appear in one of 17 classes, a sample of each class seen in (5).

(5)	Class	Noun	Stem	Gloss	Prefix
	1	mwaána	-ana	child	mu-
	2	baána	-ana	children	ba-
	3	nkʉ́n'ʉʉndo	-kʉn'ʉʉndo	sieve	mu-
	4	mi̱kʉ́n'ʉʉndo	-kʉn'ʉʉndo	sieves	mi̱-
	5	li̱kʉn'ʉ́ʉnda	-kʉn'ʉ́ʉnda	filtered beer	li̱-
	6	makʉ́n'ʉ́ʉnda	-kʉn'ʉ́ʉnda	filtered beers	ma-
	7	ki̱gómá	-gómá	cassava (sp)	ki̱-
	8	i̱gómá	-gómá	cassavas (sp)	i̱-
	9	changaláwe	-changaláwe	gravel (sg)	∅
	10	changaláwe	-changaláwe	gravel (pl)	∅
	11	lʉgó i̱	-go i̱	rope	lʉ-
	12	kalaá i̱	-laá i̱	little bamboo	ka-
	13	tʉlaá i̱	-laá i̱	little bamboos	tʉ-
	14	bweémbe	-eémbe	flour	bʉ-
	16	paki̱gómá	-(ki̱)gómá	at the cassava	pa-
	17	kʉki̱gómá	-(ki̱)gómá	to the cassava	kʉ-
	18	mʉki̱gómá	-(ki̱)gómá	in the cassava	mʉ-

My assumptions about the morphology of these noun class prefixes are the following. At level 1, most of the lexical noun class prefixes are affixed to stems – most, except the class 5 prefix *li̱-*. At level 2 the remaining lexical prefix *li̱-* is affixed, and at level 3, the locative prefixes are affixed. The assignment of locative prefixes to level 3 is well motivated on morphosyntactic and phonological grounds. The assumption that affixation of the class 5 prefix *li̱-* occurs at level 2 explains a number of anomalous phonological properties of this prefix, which acts as though it is not present for a number of level 1 rules. Such rules include Post-Prefix H Tone Assignment (PPHTA) and Accent Erasure. As seen in (6) PPHTA assigns a H to the first stem vowel of a noun after a level 1 prefix such as *ma*, *ka* or *tʉ*; hence PPHTA applies after most lexical class prefixes, but fails to apply after locative prefixes and also fails to apply after the level 2 prefix *li̱-* (for further information about Kimatuumbi tone, see Odden (1982) and Kisseberth and Odden (1980)).

(6) si̱pi̱taáli̱ 'hospital' (Cl. 9) ma-si̱pi̱taáli̱ 'hospitals' (Cl. 6)
mʉ-si̱pi̱taáli̱ 'in the hospital' ka-si̱pi̱taáli̱ 'small hospital' (Cl. 12)
li̱-si̱pi̱taáli̱ 'huge hospital' (Cl.5) tʉ-si̱pi̱taáli̱ 'small hospitals' (Cl. 13)

$$\emptyset \rightarrow H \,/\, \underset{V + \overset{\vdots}{V}\ V}{\_\_\_\_}$$

Post Prefix H Tone Assignment (Level 1)

A second phonological argument for excluding *li̱-* from the set of regular noun class prefixes is the fact that it undergoes Lengthening, one of the two rules which forms part of the ordering paradox. Regular noun class prefixes do not undergo Lengthening.

2.2. *Glide Formation*

Let us now consider the rules involved in the paradox, beginning with Glide Formation. As the data in (7) show, a prevocalic high vowel becomes a glide, with compensatory lengthening of the following vowel.

(7)	/lʉ-ánjú/	→ lwaanjú	'firewood piece' (Class 11)
	/kí-úlá/	→ kyuúlá	'frog' (Class 7)
	/lí-eéke/	→ lyeéke	'storage structure' (Class 6)
	/mʉ-í-téleéko/	→ mwiítéleéko	'in the cooking pots' (locative)
	/mʉ-aanjú/	→ mwaanjú	'in the firewood' (locative)

This Glide Formation rule applies to the vowel of lexical noun class prefixes, to the level 2 prefix *lí-*, and the locative prefixes. The high vowel of a verbal subject prefix or object prefix also undergoes Glide Formation.

(8)	/tʉ-oónde/	→ twoónde	'we should peel' (tʉ = 1p Sub)
	/a-í-oónde/	→ ayoónde	'he should peel them' (í = Cl. 9 Obj)
	/kʉ-kí-épʉka/	→ kʉ-kyeépʉka	'to avoid it' (kí = Cl. 7 Obj)

Glide Formation is formulated in (9), to detach a high vowel from the syllable nucleus, leaving behind a stranded V node, which results in compensatory lengthening of the following vowel.

(9)

Glide Formation

There are a few restrictions on (9) to be explained. First, Glide Formation does not apply between words.

(10)	ílátú ítúúmbwíike	'the shoes fell'	*ílaatw iituumbwiike
	lwáanjú alwó	'that firewood'	*lwáanjw áalwó

This restriction indicates that Glide Formation is a lexical rule. The alternative would be to assume that Glide Formation is postlexical, but is ad hoc restricted not to apply between words. This alternative can be ruled out directly, by considering the remaining conditions on Glide Formation.

The second condition on Glide Formation is that it applies from left to right, and can not apply to a long vowel. These conditions are illustrated in (11), where the infinitive prefix *kʉ-* precedes the object prefix *-í-*, which precedes the vowel-initial verb *-eleewa*.

(11)	/kʉ-í-éleewa/	→ kwiíéleewa	'to understand it' (kʉ = Infin, í = Cl. 9 Obj)

The infinitive prefix vowel glides, compensatorily lengthening the following vowel. The derived length on the prefix *-í-* then prevents that prefix from gliding. The prohibition against long vowels undergoing glide formation is an instance of the Linking Constraint (Hayes (1986)), which states that a rule which mentions the linking of the CV tier and the segmental tier must interpret those links as exhaustive. Since the prevocalic long vowel *íí* in (12) is linked to two V's, not one, long vowels do not satisfy the structural description of Glide Formation.

(12) CCVV V CVV CV

k ų j e l e ų a

Right-to-left application of Glide Formation would yield **kyyeéleewa*.

A third condition on Glide Formation is that if any syllable precedes the focal high vowel, Glide Formation is optional. When preceded by the syllable of the infinitive prefix in (13), object prefixes optionally undergo Glide Formation. In contrast, word-initial prefixes must undergo the rule.

(13)	kų-kj-áandjka →	(opt)	kukyáandjka	'to write it'
	*kj-áandjka →	(oblig)	kyáandjka	'to write it'
	naa-j-éleewíte →	(opt)	naayeéleewíte	'I understood it'

Now we turn to two arguments that Glide Formation has cyclic behavior, and is thus not postlexical. Recall from (11) that in a string of level 1 prefixes, Glide Formation applies left-to-right. Consider the forms in (14) with a locative prefix followed by vowel initial noun class prefix, followed by vowel initial noun root.

(14)	[mų [j-úlá]] → mųyuúlá	'in the frog'
	[kų [j-aáj]] → kųyaáj	'to the cooking pots'

The vowels of the locative prefixes *kų-* and *mų-* and the noun class prefix *j* are all underlyingly prevocalic, at least in the traditional sense of underlying, yet in (15) the noun class prefix vowel undergoes Glide Formation, not the leftmost prefix vowel. How then do we explain the contrast in (15) between /mų-j-ųtį/ which becomes *mwjiųtį*, and /mų-j-úlá/ which becomes *mųyuúlá*?

(15)	a. [mų [j-úlá]]	→ mųyuúlá	'in the frog' (mų- = loc., j- = Class 8 noun)
	b. [mų-j-ųtį]	→ mwjiųtį	'you should pull it' (mų- = 2pl Subj., j- = Class 8 Obj.)

The relevant distinguishing feature is the difference in morphological structure. If Glide Formation is a lexical rule applying at levels 1 through 3, then we would expect a pattern of cyclic behavior, exactly as we have here. At level 1, Glide Formation applies in (15 a.) to the only prevocalic high vowel, the class prefix vowel j-, and in (15 b.) the rule applies to the leftmost prevocalic high vowel, the vowel ų- of the subject prefix *mų-*. If at a later level a locative prefix is added as it is in (15 a.), then Glide Formation might in principle be reapplicable, – but in the present instance, Glide Formation fails to apply to the locative prefix since it is not followed by a vowel at that level of the derivation. All we need to assume is that Glide Formation applies at multiple levels, in order to get this cyclic effect. If Glide Formation is postlexical, then it should be blind to the difference between level 1 prefixes and level 3 prefixes, and all vowel sequences would incorrectly be treated alike. Therefore, Glide Formation must be lexical.

There is a second argument for the cyclicity and lexicality of Glide Formation. Recall from (13) that Glide Formation was optional when preceded by any syllable in the word. But the data in (16) run afoul of that generalisation, in that the medial syllables *kų-* et al. must undergo the rule.

(16)	*[pa [kų-áanjų]] →	(oblig)	palwáanjų	'at the firewood'
	*[mų [kj-átį]] →	(oblig)	mukyaátį	'on the family farm'

If Glide Formation applies from inner levels out (i.e. is lexical), then the predicted results are the actual results.

(17) a. [lụ-áanjụ́] *Output from level 1 morphology*
[lwáanjụ́] *Glide Formation* (oblig)
[pa lwáanjụ́] *Output from level 8 morphology*
'at firewood'

b. [a-lụ-áandjike] *Output from level 1 morphology*
[a-lụ-áandjike] *Glide Formation* (optional; not applied)
'he wrote it'

The prefix *lụ-* is encountered at level 1, and is not preceded by any syllable at that level. Glide Formation must apply, since the condition which allows optional application of Glide Formation is not present. At level 3 a locative prefix is added to the noun, but Glide Formation was previously required to apply at level 1. In contrast, when the high vowel prefix is preceded by another syllable at its own level, as (17 b.), then the prefix *lụ-* undergoes Glide Formation optionally.

In the two preceding arguments for the lexicality of Glide Formation, a pattern of cycle-like behavior was encountered. In the theory of lexical phonology, there are two sources of cycle-like behavior. If a particular level is a cyclic level, then the output of each morphological affixation is submitted to the phonology, hence each morphological process constitutes a cyclic domain. The second source of cyclic behavior is the interaction of levels: a rule found at two levels will exhibit cyclic behavior with respect to the domain defined by the morphology of different levels. The cyclic behavior found in Kimatuumbi is of the latter type, since it cannot be of the former type. Specifically, if level 1 were a cyclic level, sequences of prefixes affixed at the same level should exhibit the same type of cyclic pattern as sequences of prefixes affixed at different levels. This is not the case, as the contrasts in (15) and (17) show.

2.3. *Lengthening*

Now we turn to Lengthening. The lengthening rule is a bit peculiar, in that it is not a strikingly phonetically motivated rule. The rule lengthens any vowel in a level 2 or level 3 prefix which stands before a disyllabic noun stem with short nuclei. The data in (18) show the lengthening of underlying short vowels of the level 2 class 5 prefix *li-* and the level 3 locative prefixes *mụ-*, *pa-* and *kụ-* before such nouns.

(18)	mụụ-chụ́pa	'in the bottle'	paa-chụ́pa	'at the bottle'
	lii-chụ́pa	'huge bottle'	kụụ-ngói	'to the ropes'

I assume the formulation of Lengthening given in (19).

(19) V → VV / n [n n +noun] *Lengthening* (L2—postlexical)
| | | +stem
_ V V

Stems with 3 or more syllables or stems with long vowels do not condition Lengthening.

(20)	mụ-mbaángo	'in the cave'	pa-changaláwe	'at the gravel'

Lengthening also operates as a sandhi rule between words.

(21) /naammwéni pfli/ → naammwéɲi pfli 'I saw the puff adder'
/balyu mbuyá/ → balyuu mbuyá 'that is grandmother'

Lengthening must be both lexical and postlexical, and when it applies lexically, it applies at levels 2 and 3. Lengthening does not apply to the level 1 noun class prefixes, as seen in (22). There is nothing about the phonological structure of level 1 prefixes which prevents them from lengthening – it is simply the fact that Lengthening does not apply at level 1.

(22) kɨ-ʃíbe → *kiiʃíbe 'thing' (Cl. 7)
ɨ-gómá → *iigómá 'cassavas' (Cl. 8)

I note in passing that the failure of Lengthening to apply at level 1 refutes the Strong Domain Hypothesis (Kiparsky (1984)), which states that a grammar may only stipulate where a rule ceases to apply, and that a rule is always potentially applicable at level 1. A similar counterexample to the Strong Domain Hypothesis was presented in Hargus (1984).

As a further restriction on Lengthening, the rule does not apply to any prefix or word before CVCV adjectives, hence the restriction in (19) to nouns.

(23) mu-njinʃ → *muunjinʃ 'in the small (x)'
aatwéti njinʃ → *atwétii njinʃ 'he took the small (x)'

Lastly, Lengthening does not apply before disyllabic nouns which are composed of a CV class prefix and a CV stem. Thus, Lengthening applies only before a disyllabic stem, hence the restriction in (19) to stems.

(24) mu-kɨ-kú → *muukikú 'in the navel' (Cl. 7)

2.4. *The Paradox*

Finally we come to the ordering of Glide Formation and Lengthening, and the ordering paradox. Glide Formation and Lengthening necessarily conflict; Glide Formation cannot apply to long vowels, and Lengthening does not apply to glides. Looking at the forms in (25) where both Glide Formation and Lengthening could apply, we see that when the level 2 prefix *li-* precedes a VCV stem, Glide Formation wins out over Lengthening.

(25) [li [owá]] → lyoowá 'beehive' (Class 5)
[li [até]] → lyaaté 'huge banana hand' (Class 5)

Had Lengthing applied first, Glide Formation could not have applied, since long vowels can not glide, and we would have derived incorrect ***liiaté*. Therefore Glide Formation precedes Lengthening, at least at level 2. Now consider the interaction of Glide Formation and Lengthening at level 3. Here the paradox surfaces. The data in (26) show that when the locative prefixes *ku-* and *mu-* precede a vowel-initial disyllabic noun, one with no noun-class prefix such as *até*, then Lengthening wins out over Glide Formation.

(26) [mu [até]] → muuaté 'in the banana hands'
[mu [ígó]] → muuígó 'in the gizzard'

If Glide Formation applied before Lengthening in (26) incorrect forms like **mwaalé* would be generated. Thus Lengthening precedes Glide Formation. But we have also seen that Glide Formation precedes Lengthening in the case of the level 2 prefix /ɨ-.

It is apparent that some type of ordering paradox is at hand; Glide Formation must precede Lengthening, but it must also follow Lengthening. Yet there is no paradox at all, that is no violation of the assumption of antisymmetry in rule ordering if we modify our conception of the way ordering statements are built into the phonology of a language. If instead of being a property of the phonology as a whole, we assume that the order of a rule is a property of the phonological level to which the rule belongs, then just as we have to say that the level 1 phonology contains the rule Glide Formation and not Lengthening, we also say that the level 2 ordering of Glide Formation and Lengthening is Glide Formation before Lengthening, and the level 3 ordering of these two rules is Lengthening before Glide Formation.

Notes

* An earlier version of this paper was presented at the 1985 Winter LSA Meeting in Seattle. I would like to thank Emmanuel Manday, from whom these data were collected. The transcription of Kimatuumbi is straightforward, except that ʼ represents ŋ and ɨ and ʉ represent high tense vowels, which contrast with mid tense vowels transcribed as *i* and *u* and with mid/low lax vowels transcribed as *e* and *o*.

References

Hargus, Sharon. (1984). The default rule domain in lexical phonology. Read at the Winter LSA Meeting, Baltimore.

Hargus, Sharon. (1985). *The lexical phonology of Sekani*. Doctoral dissertation, UCLA.

Kaisse, Ellen. (1985). Connected speech: the interaction of syntax and phonology. NY: Academic Press.

Kiparsky, Paul. (1984). On the lexical phonology of Icelandic. In *Nordic Prosody III* (ed. by C.C. Elert, I. Johansson & E. Strangert), 135-164. Stockholm: Almqvist & Wiksell.

Kisseberth, Charles and David Odden. (1980). Aspects of tone assignment in Kimatuumbi. *Studies in the linguistic sciences* 10.1.125-140.

Mohanan, K.P. (1982). *Lexical phonology*. Bloomington: Indiana University Linguistics Club.

Odden, David. (1981). *Problems in tone assignment in Shona*. Doctoral dissertation, University of Illinois.

Odden, David. (1982). Separating tone and accent: the case of Kimatuumbi. In *Proceedings of the First West Coast Conference on Formal Linguistics* (ed. by Dan Flickinger, M. Macken and Nancy Wiegand) 219-230.